STUDY OF NUCLEATING EFFICIENCY OF SUPERHEATED DROPLETS BY NEUTRONS

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Superheated droplets have proven to be excellent detectors for neutrons and could be used as a neutron dosimeter. To detect accurately the volume of superheated droplets nucleated, an air displacement system has been developed. Here the air expelled due to volume change upon nucleation displaces a column of water through a narrow horizontal glass tube, and, the displacement of water is linearly related to the nucleated volume and has the added advantage of being leak free.

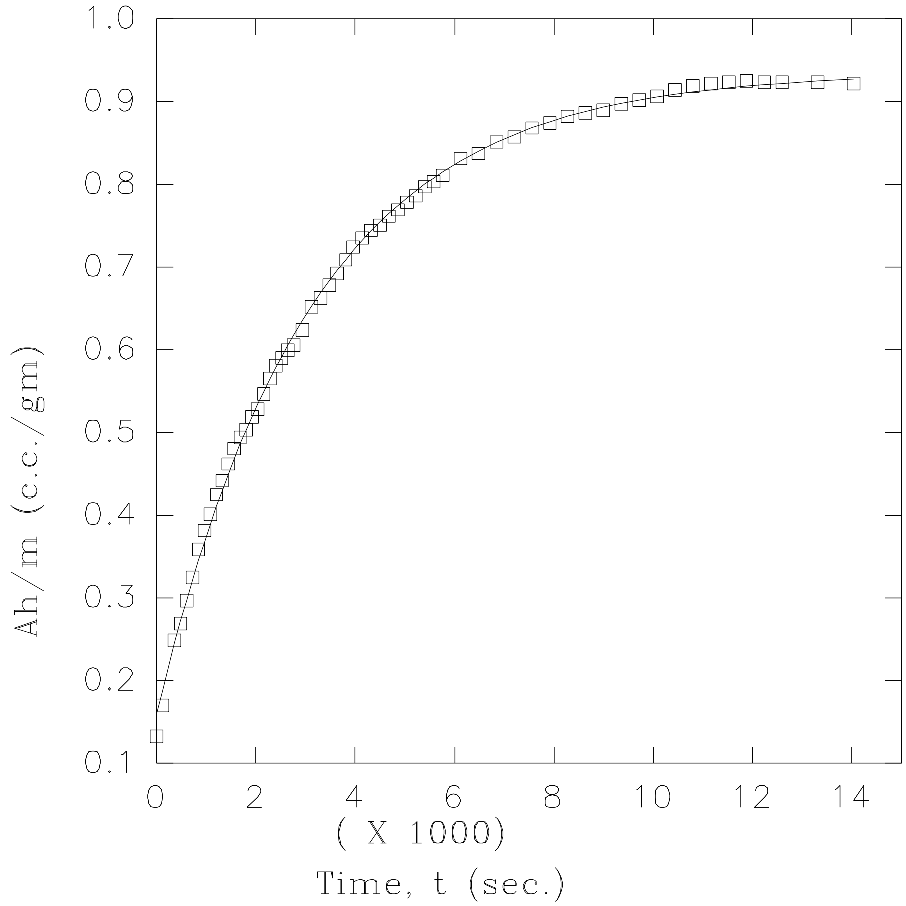
In presence of neutrons, the rate of nucleation (rate of decrease in the volume of superheated droplets) is proportional to the residual volume of superheated droplets and the neutron flux (ϕ). Hence the volume of accumulated vapour (or the volume of the displaced air) is given as:

$$V = V_0 \left(1 \,-\, e^{-t/\tau}\right) \tag{1}$$

where $\tau = \mathrm{M}/(\phi\rho\eta N_A \,\mathrm{d} \sum n_i\sigma_i)$, M is the molecular weight and ρ is the density of the superheated liquid, N_A is the Avogadro number, n_i is the abundance of the i^{th} species of nucleon (whose neutron elastic scattering cross section is σ_i) in the molecule, η is the efficiency of nucleation of the droplet by a recoil nucleon, d is the average droplet volume and V_0 is the volume of vapour of the entire superheated liquid. By least squares fitting of the volume of displaced air (V) as a function of time (t), V_0 and τ are obtained. From τ one may obtain η if the other parameters are known. Results of an experiment performed with Freon- 12 samples using an Am-Be neutron source are presented in Fig. 1.

Figure Captions

Fig.1. Variation of volume (scaled by the mass of sample and the area of cross section of the tube) of displaced air as a function of time for Freon-12; solid curve is the least-squares-fit to experimental data.


1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
Ah/m (c.c./gm)
0
2
4
6
8
10
12
14
(X 1000)
Time, t (sec.)